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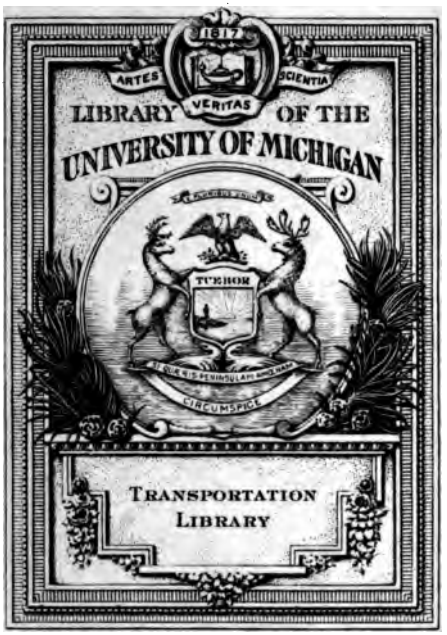
Municipal Landing Fields and Airports

Edited and Compiled by

George Seay Wheat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A Type of Field Having Possibilities for a Central Terminal for Transportation by Train, Water Craft, Flying-

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Municipal Landing Fields and Air Ports

With chapters by the Chief of the Army Air Service, the Director of Naval Aviation, and their officers in charge of Landing Field Operations

Compiled and Edited by

George Seay Wheat

Illustrated and With a Map

G. P. Putnam's Sons
New York and London
The Knickerbocker Press
1920

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GEORGE SEAY WHEAT

To

THE WRIGHT BROTHERS

FOREWORD

TRANSPORTATION is an ever-present problem of civilization, and every improvement in the means of transportation has brought about a marked advance in the intelligence and comfort of civilized people. Looking at the present day developments, it is hard to believe that the first steamship crossed the Atlantic only about one hundred years ago, or that the first railroad crossed this continent scarcely fifty years ago, or that the first American automobile was made in 1893.

Great as has been the effect upon the life of America of the development of each of these modes of mechanical transportation, yet greater still may be the ultimate effect of aerial transportation in time to come. The rapidity and ease with which aeronautical transportation is developed in America is largely dependent upon the intelligence

and thoroughness with which the way is prepared for this development. At the present time aeronautical transportation is confronted with the solution of certain great problems, which may be grouped in general as follows:

1. Development of the science of aeronautics including the design and use of aircraft, both lighter and heavier than air, of motive power, of instruments of control, communication, observation, and navigation, and of all ground equipment required in connection therewith. The technique of aeronautics has now reached a stage of perfection sufficient to make it a thoroughly practical medium of transportation for many purposes.

2. Application of aeronautics in all of its aspects to the national defence, including the procurement of the proper equipment, the development of the science of aerial warfare, and the procurement, organization, and training of the personnel necessary to make up the aerial arm of the national defense.

The world war has given all participants an

opportunity to become quite proficient in aerial warfare in terms of present day practice, but the progress of this branch of national defense during the next few years will probably continue nearly as rapidly as during the war.

3. Development and organization of the political and governmental agencies for the administration and control of commercial and civilian aeronautics for the well-being and safety of the general public.

Much more thought has been given to this phase of aeronautical development in European countries than in America. Practically every one of the principal powers participating in the world war now have well defined governmental departments charged with the development and encouragement of commercial aeronautics.

4. Development of the jurisprudence of the air by which aeronautical transportation will be given a recognized position in the affairs of the world.

This aspect of aeronautical development is complex and difficult and will require serious consideration. At the present time it is receiv-

ing attention from the State and local Bar Associations of America.

5. Development of the use of aircraft for purposes of commerce, and of facilities for making commercial transportation practical and a business possibility. This involves particularly the development of national air routes with flying fields located in every town and city over which they pass.

Of all the problems facing commercial aeronautics today the need for flying routes and landing fields is the most acute and immediate. Until these are provided, not much progress can be made in the solution of other aspects of the general problem. If these facilities are provided, commercial transportation by air will follow more rapidly than we can now realize.

This volume has been written in an effort to present to the public in concrete form the entire problem involved in the creation and administration of flying routes, landing fields, and air ports.

General Menoher, Chief of the Army Air Service, and Captain Craven, Director of Naval

aviation, have gone into the reasons for these flying routes, landing fields, and air ports in two splendid chapters.

We desire to express our appreciation for the aid furnished in the preparation of this volume by the Army and Navy Air Services, the authors of various chapters of this volume, and particularly to Major H. M. Hickam and Captain Ernest Jones.

GEORGE H. HOUSTON.

Member of American Aviation Mission to France and President of the Wright Aeronautical Corporation

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Municipal Landing Fields and Air Ports

Municipal Landing Fields

CHAPTER I

THE NEED FOR LANDING FIELDS

By Major-General Charles T. Menoher, *Chief of the Army Air Service*

The World War brought aircraft and their engines to a very advanced state of development in a short space of time; but it did nothing to develop landing fields in America. Aeronautics is in the position of a railroad with its right-of-way and equipment but no terminals.

Landing fields are as essential to flying as yards and stations are to railroads, as docks and harbours are to steamships, and when fields are established there is no question but that aircraft will utilize them. Remember there are around twenty-five

thousand one time army and navy fliers in the United States. Landing fields will get them back into the "game."

The example of automobilists who patronize the towns and cities blessed with good roads will be followed by fliers in establishing air routes from point to point connecting all the cities which have good landing fields. One thing is without argument. The locality failing to provide an aerial port will certainly be without this means of transportation.

Landing fields should be established under municipal control by cities and towns. Many individuals and corporations are ready to purchase large numbers of planes and airships for passenger and express service, when assured of the establishment of these landing fields. The traverse of the United States by regular lines running airplanes and airships carrying passengers, express, mail, and light freight is dependent directly on the speed with which our country provides these facilities.

The element of risk, unnecessarily associated

Steel Frame Corrugated Metal Cover Seaplane Hangar.

with flying, is at once removed by a wide-spread network of airdromes. Safety in cross country flying depends upon the possibility of being able to land conveniently upon properly prepared ground. The problem of insurance for aircraft, crew, passengers, express, and freight is directly modified by the number and character of landing fields over any particular route.

The business and industrial interests of the country are reminded that by aiding in the development of commercial flying they are contributing in no small way to national defence. The future development of aeronautics and the allied sciences depends on the growth of commercial, sport, and governmental flying. Inventions are sure to follow commercial demand. With the best engineering thought in the country centred upon such problems, the United States, the birthplace of flying, is sure to keep in the van of aeronautical development.

CHAPTER II

THE PRESENT PLIGHT OF FLIGHT

By F. B. Rentschler, *Vice-President, Wright Aeronautical Corporation*

We are confronted today by a system of transportation which is failing to function satisfactorily. Food and clothing and other necessities of life may be transported with difficulty. Prices are rising and are continuing to rise despite optimistic reports to the contrary. Commissions and investigating bodies are digging down deep into these problems and are suggesting remedies. That most frequently suggested is, "Improve the transportation situation; then the essentials of life may be promptly transported from the source of supply to the seat of demand."

Such a suggestion at the present time, however, might be compared to a physician who writes a prescription which he knows the chemist cannot

fill. The railroad situation cannot possibly be greatly improved, because, due to labour conditions and a volume of business far exceeding railroad mileage growth, the railroads literally are swamped. High prices of labour and materials make rapid growth next to impossible; that is, a building program adequate to supply the increased demand for tonnage transportation is out of the question. Not a little bearing on this phase of the situation is the attitude of the present-day investor. He does not know what is going to happen to the railroads and he is careful about investing in them.

In view of the general public knowledge gained of aeronautics during the war, I think I can safely say, and that the reader will agree with me, that the aeroplane has a great potential bearing on the solution of the transportation problem in the United States. He must admit that the airplane is speedy, but how about its economical use and its safety? In the first place, compare the amount invested in airplane routes and those of the railroads. The only investment required for the

former is the engine and plane and the landing fields at flight terminals, while the latter must have a right of way, grading, crossties, rails, cars, locomotives, and all the enormous expense of upkeep and maintenance. Of course, the railroads will always have their place, for I am not one of those who sees in his own profession a panacea for all evils. The railroads will, so far as we can see now, transport coal, heavy machinery, and bulk commodities more cheaply than the plane, but the latter can, at this very moment, transport passengers and the lighter types of express much more rapidly, and, as soon as certain problems, easy of solution, are taken up by the business men and the government and solved, the airplane can handle passengers and express with greater safety than the railroad and more economically when the factor of actual time saved is taken into consideration.

These problems, so easy of solution when the importance of the matter is nationally realized, are:

1. Adequate and proper legislation by the

federal government regulating the manufacture and flight of aircraft.

2. The construction of landing fields in every municipality, insuring a large number of terminals for air routes, and emergency landing fields between such terminals where airplanes in trouble may safely land in an emergency.

Included in both problems is the great factor of safety. To take the first: An airplane should be "government inspected" and "certified" like a steamship or steamboat. So should the pilot and crew stand government tests and measure up to government requirements. A man may not be the skipper of a marine vessel unless he holds a "ticket" and this ticket isn't given until after a stringent examination. On the other hand, at the present time, any crank inventor may "invent" an aeroplane; he can designate any one to fly it; and if a catastrophe results to the flyers or to innocent men and women upon whom it may fall, why, the inventor is "sorry" and there is an end of the matter. No, not quite the end, for the reading

public stores up in that section of the brain devoted to "risky things" the entire art and science of flying. Aeroplanes and aeroplane engines, properly constructed, are safe. Properly flown they are safer, and—here's where the second problem comes in—with the proper number of landing fields, aviation, as a dangerous science, will compare more than favourably with automobiling.

It is with problem No. 2 that this book deals. It is problem No. 2 which the business men and commercial organizations of this country can solve or certainly greatly help in the solution. We believe that when the business men, say of Hagerstown, Maryland, realize that as passengers they can save time (which after all in these days is money) by taking passage in an airplane when they want to go to Cleveland or Atlanta, or that they can get clothing from New York or the New England mill centres quicker and cheaper by airplane they will quickly construct a Municipal landing field. But, unfortunately, that is putting the cart before the horse. The auto-

mobile could never have hoped for its present-day use and success if good roads had not been constructed. Railroad locomotives and coaches and Pullmans would never have been built and lines started if the roadbed and rails—if the roadway, had not been possible. So air routes connecting Hagerstown with New England and the South will not become realities until all the Hagerstowns on the route build suitable landing fields.

That is the end we are trying to further. In this book will be found all the information necessary for a municipality, commercial organization, or business house to construct a landing field and build a hangar. The idea of getting out this information was suggested by the large number of inquiries of various commercial clubs on this subject and the genuine interest displayed over various parts of the country in the question. We know that aviation is on the eve of its greatest development and the far-sighted town which arranges now for its landing field will favourably compare in enterprise to those towns in the long ago

40's and 50's which held torchlight processions and municipal rallies to raise the money to "buy enough bonds to get the railroad extended here." Some old-timers, particularly in the West, can remember those days, can recall how "business grew" once the locomotive began to draw the passenger and freight cars into the town. It was the way the town "got on the map."

If your city has a municipal landing field, it will also "get on the map," the aerial map of the United States, which is shown at the end of the volume. And don't worry about planes not coming if you have the field. Some of the twenty-five thousand officers and pilots in the army and navy air service during the war live in your town or near it. They will get into the game again if properly encouraged. The Post Office Department is almost daily extending the aerial mail service, and a landing field is the best possible invitation to induce a daily mail plane to call on you, and the army, constantly conducting cross country flights of various kinds, will call at your field frequently.

A Race Track Used for a Landing Field.

The American aeronautical industry and members of our Congress expect to attend to Problem No. 1 at an early date. With proper inspection of planes and engines, with the necessary licensing of pilots and crew will come "safe flying," provided the landing fields are there. With safe flying will come public confidence and with public confidence production will increase by leaps and bounds, and with uniform production will come economical flying.

Another feature of this development which is all important I will touch upon briefly. It is that of national defence. Remember, a commercial plane can be converted into a war plane within a few hours. Remember, Britain, France, Italy, Japan, Roumania, and even Germany have solved Problem No. 1 and are rapidly solving No. 2. Don't forget the enormous waste immediately following our entry into the late war, all due to the fact that there was no such thing as an American aviation industry with any sort of organization at all.

Don't forget that we cannot afford to be behindhand in this country, the birthplace of flight.

CHAPTER III

HOW TO CONSTRUCT A FIELD

By Lieutenant F. O. Carroll, *Landing Field Officer, Army Air Service*

The landing field of the future will assume equal value with the railroad station and the shipping dock in the important matter of public transportation. A railroad corporation or a shipping company spends a great amount of time and money in selecting sites for its terminals which will provide easy access to the public, having at the same time due regard for future expansion of business. The problem of aerial transportation is a new one. It takes little imagination to conceive that in a very few years this new system, established for the more rapid movement of men and merchandise, will form aerial lanes from all the important commercial centres of this country and of the world. But,

since this agent of transportation floats in the ocean of air surrounding the world, the question is immediately raised as to where and how contact with earth will be made. And herein lies the answer as to whether this form of transportation will develop and expand until its lines cover the earth, or whether it will shrivel and die away with the passing of war.

Trains have their stations, ships have their docks, but, so far, very few terminals have been constructed for the taking off and landing of airplanes. Landing fields are absolutely essential to the operation of airplanes. During the war the government spent vast sums of money for the building of fields and hangars from which airplanes could be flown and kept in flying condition, but with the coming of peace many of these have been closed, and today this country is practically without facilities for the operation of airplanes on a commercial basis. What, then, is to be done? The solution of the problem is to arouse the interest and secure the co-operation of the cities in this

important national enterprise, and make them see that their future and the future of the country depends on the establishment of landing fields, each field having the proper aeronautical facilities for handling the aerial commerce that comes down to it.

Developments so far are following the commercial routes of the country, just the same as the first continental railroads followed the routes of the Conestoga pioneers. These early western settlers, in their picturesque prairie schooners, chose the easy and natural land routes leading from the East to the West. Cities along these routes should be the first to establish fields, for if they do not, they may awaken to the fact that the pilots of the air, who are not hindered by mountain barriers, deserts, and streams, have chosen a more hospitable route, and the opportunity that was theirs has been grasped by other cities.

Assuming, then, that the cities see that they are in need of landing fields, the question will arise as to the manner of constructing a land-

ing field and what facilities should be placed thereon.

Probably the most important point is the location of the field. The field should be situated close to transportation facilities of either railroads or shipping, and in cities having both, readily accessible to either. The movement of passengers, mail, and express by air will be interlinked with these two prime movers of commerce. It, therefore, should be easy to transfer from one to the other. Valuable mail and express may need to be shipped into an aerial centre by rail or water and then transported to a great distance by air in a minimum space of time. Business men or government officials may be required to meet in distant cities within a few hours' notice, and they will demand that little time be lost in transferring from one type of transportation to another. It may happen that medicine and supplies may be needed immediately by some section of the country to combat pestilence, or disaster, and no time should be lost in changing from a surface to an aerial

route. The successful defence of the nation may depend on minutes gained in the transfer of troops. So it is seen that these systems should be so correlated that all will work together as one great system, and this will depend on the location of one terminal with respect to the other. Proper attention should also be given to the question of electric power and water supply. In the future electric power will be needed for lighting the hangars, repair shops, and the field. It will be needed for running the machinery, and for the operation of the gas plants at every field handling lighter-than-air ships.

With due consideration of the above, the selection of the location of the field should be made where it is unlikely to be later surrounded by building operations. As time progresses a city will undoubtedly increase the volume of its aerial traffic, and if this point is not considered at the beginning, it may find itself handicapped for lack of space. Many cities are converting the race tracks of their fair grounds into landing fields. Most of these

A Landing Field to which Access by either Rail or Automobile Could be Readily Made.

fields are of sufficient size to accommodate the few airplanes of today, but these cities should take warning that the limits of such fields are already established, and in few cases can they be enlarged because of the surrounding buildings and other aerial obstructions.

The next point of great importance is the size of the field. The size of municipal landing fields depends upon so many factors that it is impossible to prescribe exact regulations concerning it. It is also realized that every city will not be able to establish an ideal field, and that many will not be able to meet the requirements of government specifications. The problems will be individual to the city or the locality and every city will face a different one. It will naturally not be possible for cities situated in hilly or mountainous country to find a site with the ease that will be experienced by cities in level country. Likewise, it is going to be difficult in large cities where property of sufficient size for landing field purposes will be very expensive. Small cities will perhaps have less

trouble and expense. The minimum size recommended at the present time and with present types of airplanes is one that will allow six hundred yards "runway" in any direction from which the wind may be likely to blow. Such a field would permit any type of airplane at the present day to be landed by an average pilot, and to be taken off without accident, should there be no failure of the motor. But this size field should be selected only after long search and failure to find a field of larger dimensions. No doubt in a few years airplanes will increase in power and size almost beyond our present conception. They will be of such dimensions that the passengers will be numbered by the score and the express and freight will be weighed by the ton. To have a field large enough to enable the average pilot to take any and all types of airplanes away from the field and keep the airplane always in such position with reference to the field as to be able, in case of failure of the motor, to return to it and to land the airplane without accident, would require a "runway" of at

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least one thousand yards in any direction from which the wind is likely to blow. Fields complying with these specifications are designed to take care of present airplanes of all types under all conditions of traffic and weather. These specifica-

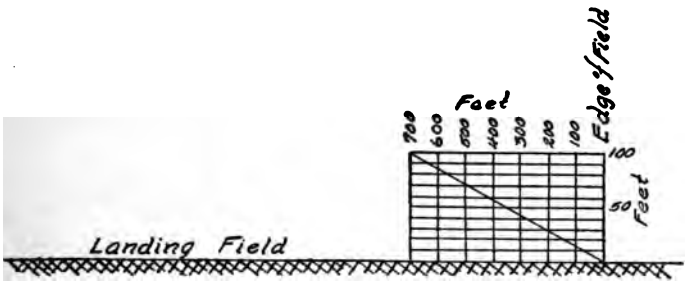


Diagram showing space unavailable for landing on "runway" when landing over obstacles of given height.

tions are not intended to discourage the establishment of small fields, as the presence of small fields en route is of vital importance, and, as such, they will function as emergency fields for small and slower types of airplanes. They will have an important rôle as feeder stations to the main lines. Aerial routes in England are contemplated having small emergency fields every ten miles, in which case an airplane would almost never be out of gliding distance

of a field. Should there be obstacles around the field, the portion of the field available for use will be shortened by a distance depending upon the height of the obstacle. An obstacle one hundred feet high will make at least seven hundred feet of the field unavailable for use. The length of the "runway" available for use should be computed by subtracting seven times the height of the obstacle from the length of the field in the direction in which the "runway" is being computed. Another factor which enters into the size of fields is the question of the surrounding country. Should a field be situated in a locality where there are fields available for emergency landings immediately adjacent to the municipal landing field, the danger of accident due to failure of motor, immediately in the vicinity, will be much lessened and the need of a one thousand yard "runway" is not so urgent. Should the country surrounding the field, however, be covered with buildings, or be of such a character that it is impossible to land upon it with safety, the best interests of aeronautics

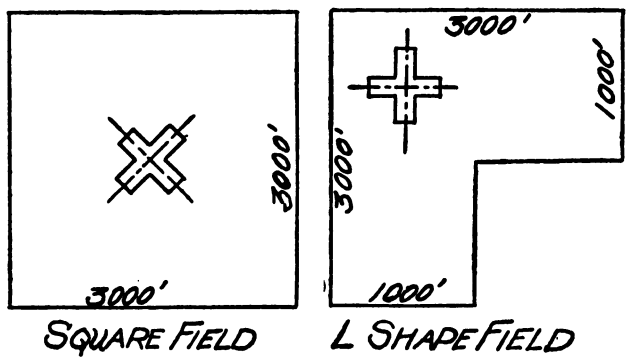
demand that the field should be large enough to enable the pilot to circle it in any type of airplane, keeping always in such position as to be able to return in case of necessity.

There are present-day types of airplanes with which it is possible for the average pilot to land in a field, without chance of accidents, with much less than a six hundred yard "runway." It is also possible for good pilots to land any type of airplane in fields of smaller dimensions than five hundred yards, if there are no surrounding obstructions. It is not advocated, but rather discouraged, that any city go to much expense in preparing a field with less than six hundred yards "runway," as it is feared that accidents will result in such a field and that public sentiment will become adverse to aerial operations in that community. The selection of a landing field of dangerous dimensions, which may result in unnecessary loss of life, should be discouraged at all times.

An examination of the list of landing fields recorded in this book will indicate that the greater

percentage of them are listed as emergency fields. This is merely an indication that no effort, aside from selecting them, has been made to make them first-class airdromes. Many of these fields are ideally located, are sufficient in size to accommodate all types of airplanes, and have smooth, level surfaces, but no supplies are available at the field and no protection is afforded an airplane from the weather if the pilot wishes to stay over night. Others are small fields that need development to make them of commercial importance as flying fields. Although some of these fields are unsuited for many types of airplanes, still they are a great asset to aeronautics, in that they are a centre about which interest in that community may be aroused and an effort made to develop a field to meet the present-day requirements of aeronautics. Small fields will always be of value to commercial aeronautics. They will be needed in case of trouble which will force an airplane to the ground. The pilot will feel more at ease if he knows that there are fields in which landings are possible in case of

trouble. Small fields should not be selected if it is anyway possible to select a large field, but if the larger one is not available the emergency field will be of great aid along the route. Landing fields so far established are of all sizes and shapes,



Sizes and types of fields recommended as sufficient to accommodate all present day airplanes.

ranging from small race tracks to large square or rectangular fields. The best shape for a field is that of a square. A square field permits of an easy return in case of motor failure. Many times, however, the condition of local terrain does not permit the selection of a square field that will be large enough for flying purposes. In some cases an "L"-

shaped field may be chosen, provided each arm has a satisfactory length of "runway." The width of each arm should be not less than a third of the length of the arm. The "L"-shaped field, however, does not offer all the advantages for a return in case of motor failure which are possessed by the square field.

It would be well to equip the field with a landing cross. While one is not absolutely necessary and can very well be made a part of a development scheme to be provided for after a field has been in use and the traffic warrants, it will become a more and more important factor as the traffic increases. Such a cross can be most easily made by excavating a path 150 or 200 feet wide, the length according to the size of the landing field. This excavated path must be thoroughly drained and given a top dressing of cinders, well watered, and then rolled. The surface must be flush with the rest of the field. The width of the cross may be narrower than 200 feet, even down to fifty feet, but a good wide path is highly desirable.

An Active Commercial Landing Field, Rectangular.

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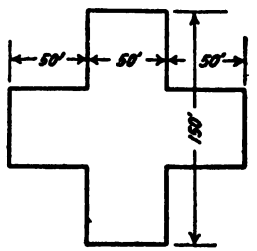
A Type of Field with Adjacent Land Suitable for Emergency Landings in Case of Motor Failure on the Take Off.

UNIV. OF MICH.

HOW TO CONSTRUCT A FIELD

During the war the military airdromes on both sides of the lines had concrete service runways and crosses built especially for the starting and landing of the heavy bombing planes. A cross of such material would be ideal and it is believed that such crosses will come into existence for commercial work when the traffic warrants it. The thickness of a concrete cross is entirely dependent upon the nature of the soil upon which it is laid but it should be noted that it need not be heavier than would be required for light vehicular traffic. An even lesser thickness probably would be entirely satisfactory if the foundation is good.

CONCRETE LANDING CROSS



Design for a concrete or cinder landing cross. Also makes a distinctive field marker.

The type of soil that goes to make up the landing field should be given considerable attention. Even slow landing airplanes of today land at high speeds as compared to the speed of any land vehicle.

MUNICIPAL LANDING FIELDS

Landing speeds of from 45 to 75 miles per hour are quite common in modern airplanes. It is therefore easily seen that an airplane rolling along the ground at the speeds above mentioned would require smooth, firm soil to prevent accident. The ground should be firm under all weather conditions. A light, porous soil with natural drainage is recommended as the most suitable.

The adequate drainage of landing fields is of the utmost importance, especially in parts of the country where the precipitation is fairly heavy, or the land used is low lying. In selecting a field, if one can be found where the sub-soil or the position of the field gives natural drainage this is much to be preferred. However it is often the case that other prerequisites of a landing field require the selection of a site which needs thorough drainage so that it may not be boggy at any time. Adequate tile drainage such as would be used for the sub-soil drainage of a football or baseball field should be satisfactory, except that the drain should be rather more closely spaced. On most athletic

fields the object is to drain the ground for a short period of time and not necessarily keep it as clear as possible from water at all times. The city engineers in any municipality could give the necessary information regarding drainage of any particular local site. If a drainage system is provided the ground will dry out very rapidly, thus making it safe for airplanes to use the field in a very short time after a rain. A field that remains soft and muddy is likely to cause many wrecks of a minor character, resulting in damage to wings, radiators, and propellers due to turning over when taking off or landing. A good drainage system will be of great advantage to northern fields in the spring when the frost is coming out of the ground. Many fields at this time of the year become very soft, due to the fact that the frost on melting remains in the soil and has no way of drying out except by evaporation. The field should be covered with sod, which will prevent an airplane from sinking into the ground on an otherwise soft field. The surface should be level and

very smooth, in order that the airplane can normally land upon and taxi across it without injury.

Many accidents have been caused by airplanes striking against trees, poles, and wires about a field, either when landing or taking off. A field should be selected as free as possible from any surrounding objects that may obstruct an airplane in getting into or out of it, or else one where such obstructions may be removed. Some fields have been established in deep valleys. This type of field should be entered with care owing to the irregularity of the wind currents that eddy into a valley during high winds. These currents may be so strong as to carry a low-powered airplane into some obstruction. Especial care should be taken about a field which is located near high tension wires due to the increased danger from fire. Buildings erected on a field should be designed with special care so as not to obstruct the approaches. Buildings should never be erected with high towers or flag poles on top of them, for at times these obstructions are very hard to see from the air.

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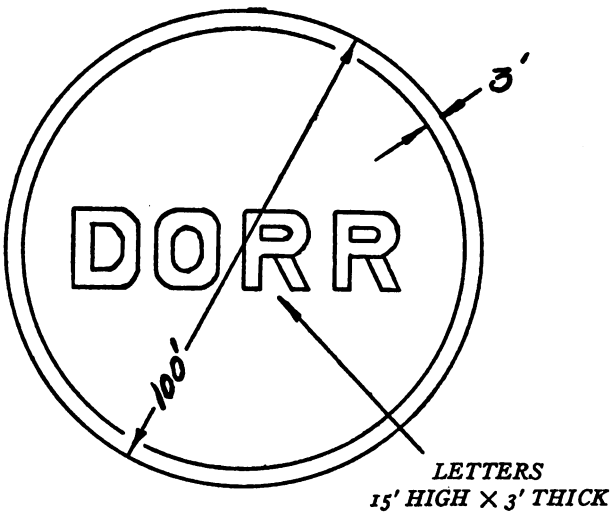
HOW TO CONSTRUCT A FIELD

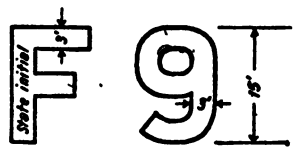
Tall chimneys, wireless and observation towers should be erected away from the field, because they are very dangerous when fog or low clouds obscure them.



Design for a landing field marker.

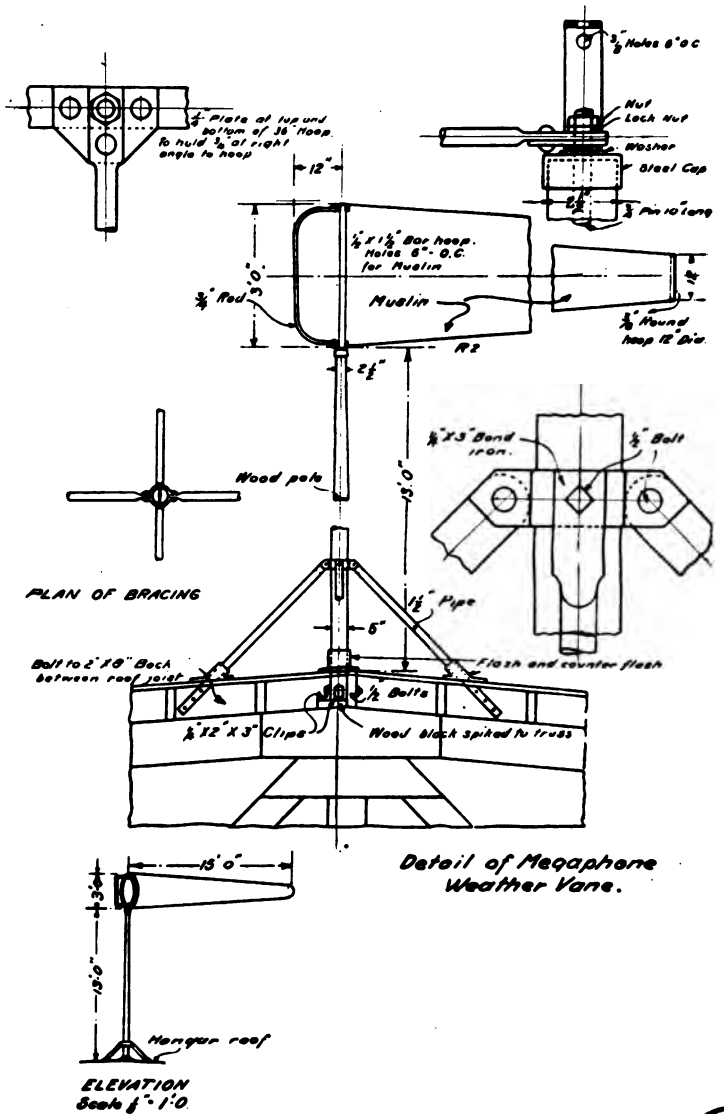
When flying across country the pilot will see many fields that look very much alike, and at times it is very hard to locate the proper field if some distinctive marker is not displayed. There are several methods of marking a field, but one of the best is a white circle, one hundred feet in diameter,

with a band three feet wide. This type of marker readily attracts the eye and can be seen at almost any attainable height with clear visibility. By digging out the earth to a depth of about six inches and filling in with crushed rock a very substantial and economical marker can be made. It may also be made by using whitewashed gravel. It is necessary to keep the marking clear white to make it show up well. This can be done by whitewashing from time to time. The name of the station should be made in white letters fifteen feet high and three feet wide. The official number of the field should be placed in the northwest corner and should be of the same dimensions as the name of the station. A wind indicator, such as the standard aviation wind cone, should be placed at one corner of the field thirty feet off the ground.



Design of lettering for landing field number to be placed in northwest corner.

The marking and lighting of landing fields for



A Drawing for the Standard Aviation Wind Cone.

UNIV. OF MICH.

night operations has never been given much attention in this country outside of a few government fields where night flying was carried on during the war. The system used, for the most part, was the very simple one of placing oil flares on the field arranged in such a manner as to indicate to the pilot the existence of the field and illuminate the landing area. The position and design of the arrangement was such as to show the pilot the direction of the wind and the exact place to land to avoid obstructions. Red lights were hung on towers and other dangerous objects.

The system in use at Ellington Field, Texas, was to have units of five Davis flood lights, four of which were arranged in line to the left of the landing area parallel with the direction of the wind, and the fifth facing the wind. The four in line were set at decreasing angles into the wind as they approached the fifth light, over which the pilot landed. This arrangement was used so that the glare of the lights would not be thrown in the pilot's face. A series of col-

oured lights were also used for signals to the pilots in the air.

Other systems have been proposed where

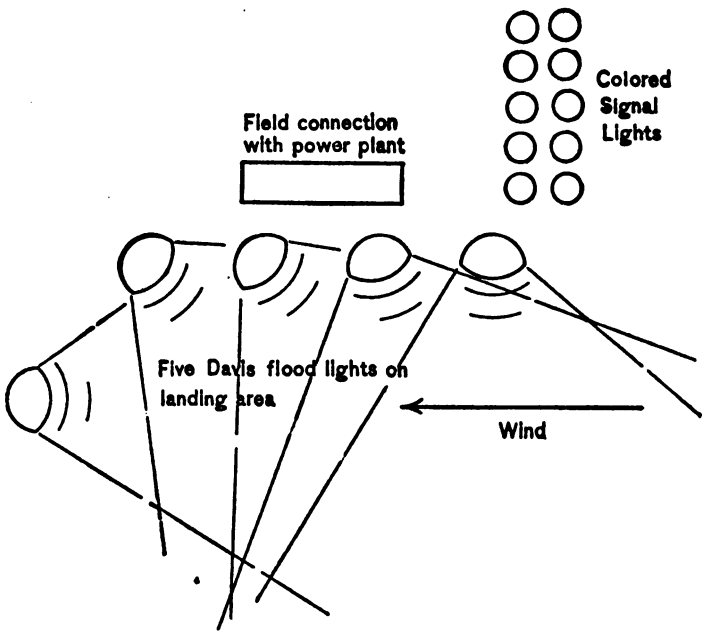


Diagram of Davis flood light system used at Ellington Field, Houston, Texas.

strong lights were placed in pits on the field and covered over with heavy plate glass, so that their rays would be thrown straight up and thus afford

distinctive markers for the incoming pilots. Flood lights are often used about the edge of the field to light the landing areas.

The greatest problem in lighting a field arises when the airdrome is covered with a heavy fog. In this case a system is required which will throw light beams upward through the fog, so that they will be seen by the pilot as soon as he passes down from the clear air above into the upper layers of the mist. The difficulty in this system comes in obtaining a ray powerful enough to pierce the fog, and one which will not be dispersed when it strikes on the heavy fog masses. However, with present-day searchlight equipment it should be possible to indicate the outline of the field by means of lights placed at intervals along the edge and throwing powerful rays vertically upward. It is also proposed to station kite balloons over a field at such altitudes as to clear the upper layers of the fog.

Another system for locating a landing field at night or when the ground is obscured by fogs and

low clouds is now being perfected by government experts. By the use of radio instruments an airplane can locate a field by keeping within a restricted area that is energized by apparatus stationed on the field.

A Tent Hangar Just Large Enough to Accommodate One Airplane.

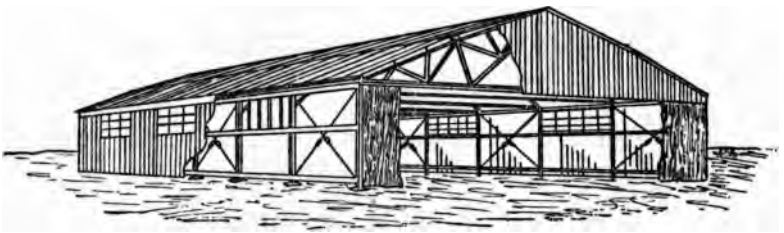
CHAPTER IV

AIRCRAFT HANGARS

By LIEUT. C. M. KNIGHT, *Buildings and Grounds Section, Property Division, Army Air Service*

A HANGAR is a tent or building in which aircraft are housed for minor repairs and for supplies, or for protection against the weather. A hangar may be of any size, depending on the type of aircraft and the number of machines to be taken care of. The smallest type in use at present is a tent hangar built just large enough to hold one airplane. Where the owner has only one airplane this type of hangar is a very good one, since it costs but little, is easy to erect and maintain, and may be moved from place to place if he happens to be engaged in exhibition flying. However, if more than one airplane is used on an established field the wood or steel hangar is to be preferred, because

of its more permanent construction. The wood or steel hangars are built in various sizes to accommodate the number of airplanes in use, or to take care of anticipated aerial traffic. They are usually built in sections of twenty-foot length and about



A good type of hangar

fifty to seventy feet wide. The standard steel hangar used by the United States Air Service is sixty-six feet wide and one hundred and twenty feet long, made up of five twenty-foot bays. It has a clearance overhead of about eighteen feet and will house six airplanes very conveniently. The standard wooden hangar of the Air Service is of the same dimensions. A still larger steel hangar, having a width of 110 feet and a length of 140 feet, is used for large bombing or commercial machines. Hangars

of this latter type will house very nearly all airplanes of the present day.

The hangar should be erected on one edge of the field. The building should be free from poles, towers, and all other obstructions that will tend to cut off the approach to the field. A hangar should have sufficient fire fighting apparatus placed at convenient points about the building.

It is believed that a field to be able to handle ten to fifteen airplanes per day should be equipped with gasoline storage capacity of about two thousand gallons of high test gasoline, and about 250 gallons of mineral and castor oils. The gasoline will remain at a more even temperature and with less risk from fire if stored in underground tanks. Both gasoline and oil tanks should be located near the starting line for the airplanes so that the gas and oil may be pumped directly into them with the standard commercial gas and oil pumps.

All oil and gasoline storage tanks should be

placed at least fifty yards away from the hangar. A sufficient number of windows and a good lighting system are very necessary in order to properly repair the airplanes and aid in their inspection.

Naturally, two hangars are preferable to one and the army specifications suggested for the "ideal" municipal landing field include two steel buildings, approximately 66 × 120 feet, with concrete floors. Of course, these are expensive, and the cheaper types can be made to do until a sufficient number of planes warrant the more expensive field. A tentative list of equipment for a municipal landing field unit has recently been drawn up which fixes the probable cost at figures approximating $60,000. I hesitated at giving this figure for fear it might make some of the smaller municipalities give up at once as financially impossible any idea of establishing a field and to them I must say that a field with a smaller amount of equipment can be made very efficient. What we want them to do is to make a *start.* However, it is well to know just

what the equipment of an ideal, though expensive, field consists of, and therefore the list is given in full below. It will be noted that it includes personnel as well.

HANGARS:

2 Steel Hangars, approximately 66 x 120 feet with concrete floors.

BUILDINGS:

1 Machine shop and supply house, approximately 30 x 40 feet.
1 Low building for office, hospital, and radio combined, of approximately 15 x 150 feet.
1 Oil house, approximately 10 x 10 feet.
1 Garage, approximately 20 x 50 feet.
2 Double quarters, non-commissioned officers, married.
1 Bachelor quarters to accommodate 15 non-commissioned officers and enlisted men.

TRANSPORTATION:

1 Light truck, 1½ ton.
1 Truck, 3 ton.

1 Aviation trailer, 2 wheel.
1 Motorcycle with side car.
1 Ambulance.

ACCESSORIES AND EQUIPMENT:

1 Complete unit of radio telephone, telegraph, and directional finding.
1 Field flood lighting set.
1 Signal system, including signal.
1 Machine shop equipment including:
  1 wood lathe.
  1 band saw.
  1 forge.
  1 grinding wheel.
  1 welding outfit, hand tools, etc.
  1 drill press.
1 Office equipment.
1 Filling station of approximately 2000 gallons of gasoline and 250 gallons of oil.
  (This probably might be installed at the expense of an oil corporation.)
1 Field marker.
1 "Tee."
3 "Socks" and supports.

AIRCRAFT HANGARS

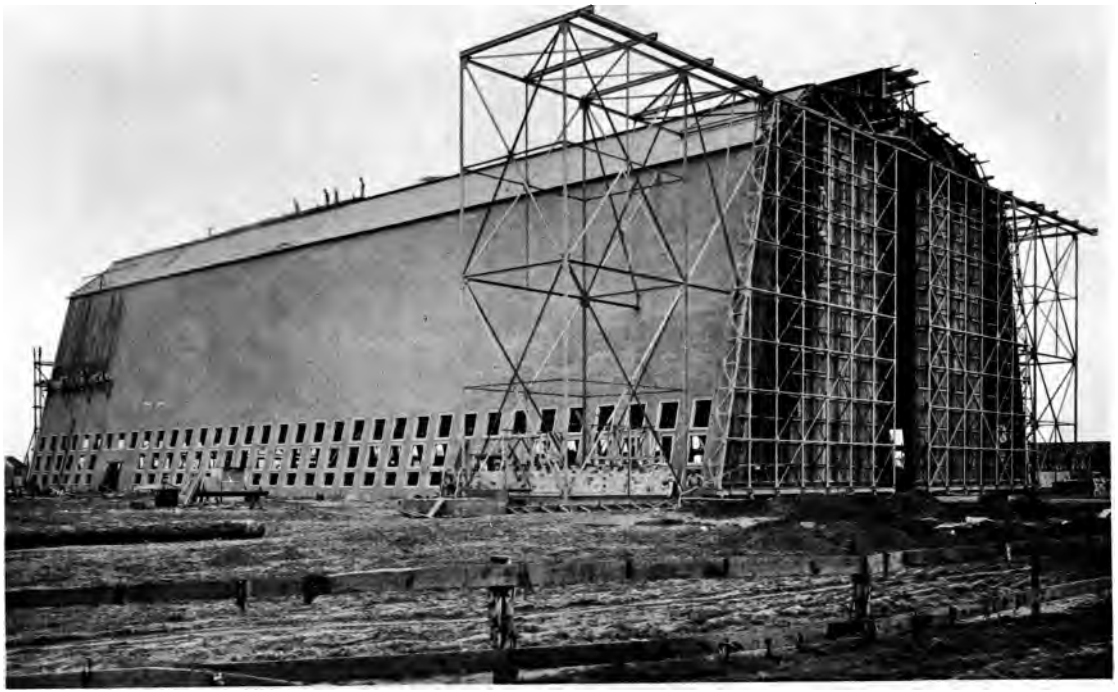
PERSONNEL:

1 Field manager.
  Should have had practical experience as a flier and as an engineering officer.
1 Chief mechanic (non-commissioned officer).
1 Rigger (non-commissioned officer).
1 Engine expert (non-commissioned officer).
1 Radio mechanic (non-commissioned officer).
1 Balloon mechanician.
  (This is only to be provided for the future when there are commercial lighter-than-air craft.)
1 Mechanic (metal worker) (private).
1 Mechanic (wood worker) (private).
4 Helpers (privates).
2 Chauffeurs (non-commissioned officers).
1 Hospital sergeant (non-commissioned officer).
Approximate total cost $60,000.

A smaller commercial field might make out very well with the following personnel, which would reduce the expense considerably: a manager who understands the handling of aircraft, an experienced aircraft engine man, one rigger and one gas

man at lighter-than-air fields, a good metal worker, and a few general helpers, the number depending on the volume of traffic handled.

Hangars for balloons and lighter-than-air craft will be needed in the future along the main air routes of the country. The airship with its great radius of action will require very few hangars, and these will usually be established at the ends of very long flights. On such routes as the transcontinental there will probably be a hangar on each coast and one located somewhere in the central west. A building to house aircraft of this type is a very large structure, some of them being 1000 feet long, 250 feet wide, and 180 feet high. Huge structures of this type, however, are not required for the smaller airships in use at present in this country. Due to the enormous surface an airship presents to the wind it is very hard to handle them in a cross wind near the ground, so it is customary to build the hangars parallel to the general direction of the prevailing winds in that section of the country in which they are located. Sometimes the



Steel Frame Wood Cover Dirigible Hangar.

wind may be blowing at an angle to the axis of the hangar, and to provide for such an emergency wind screens are built twice the length of the airship on each side of the space at the entering end of the hangar. At least two more ship lengths should be free from obstructions such as trees, houses, poles, and wires.

These hangars will have all the facilities for the repair of the gas bags and the framework of the airship, for the filling of the gas bags with hydrogen or helium, and all other machinery for lighting and operating the building.

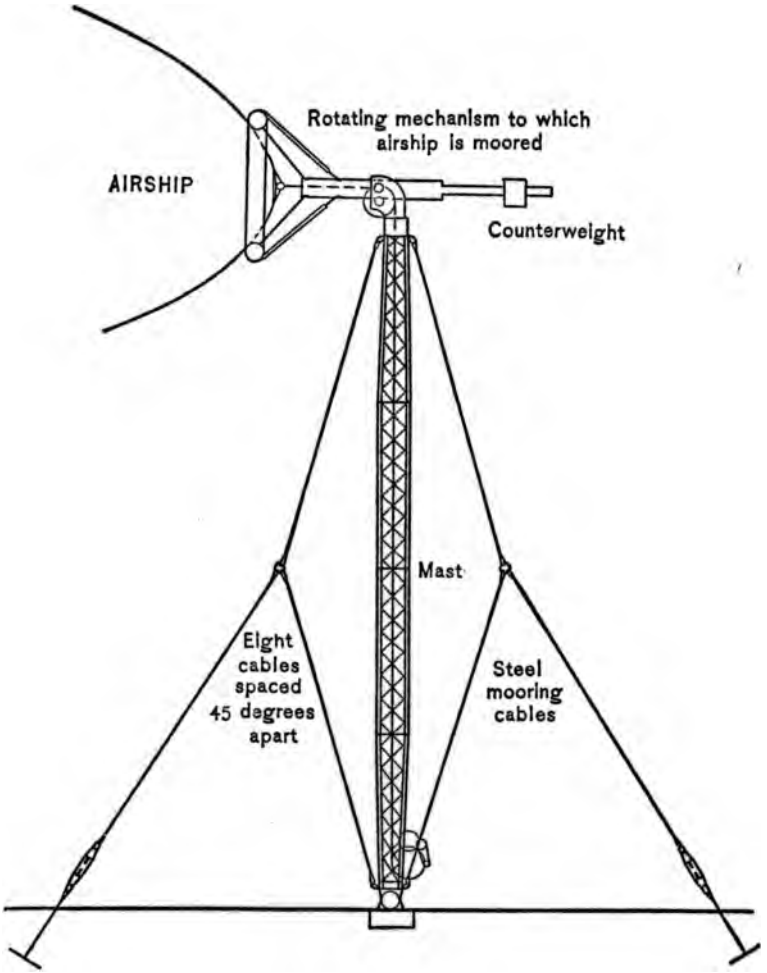
Large tent hangars have been constructed for airships, but these are usually of a temporary nature and may be moved from place to place as the requirements of the service demand.

Many airship fields may be established that will act as connecting points with other aerial routes. The airships operating through these stations may not be required to stop but a short time, and in such cases it would not be necessary to run the airship into a hangar. On fields of this type a

mooring mast may be erected to which the airship may be moored for the short time it will stop to take on fuel and passengers and discharge its cargo for that point. In places having moderate winds such masts might take the place of expensive hangars.

The mooring mast illustrated is built to moor small airships. The masts of the future, necessary to handle airships of from five to ten millions of cubic feet of gas capacity will have equipment for refilling the gas bags and oil tanks. This will be accomplished by forcing the gas and oil through pipes running up the mast and connecting with filling pipes installed on the airship, which run out to the point of attachment between the ship and the mast.

In concluding this chapter I wish to draw the reader's attention to the fact that, after all and despite what may seem a wealth of detail in connection with the subject under discussion, a location for a landing field of a good type will not be hard to find in the average community in the



Steel mooring mast to which airships may be anchored for a short time where a hangar is not available.

United States. It has been shown that the first considerations are the size and surroundings; the next, the character of the soil and drainage; the question of the convenience of the location, and, finally, the markings and the field equipment.

As previously stated, a municipality may have a fairly good field without going to the expense of furnishing it with all the modern and variegated equipment which the formal specifications given in this chapter call for. Quite naturally, the better the field is equipped the more flyers it will attract. However, what we desire municipalities to do is to *make the start.* If you can't afford a complete field, put in a small one and increase its equipment as aerial traffic increases.

To use a slang expression, the municipalities either through governmental or civic agencies must "start the ball rolling" in this matter. The federal government and the aircraft manufacturers are willing to do all in their power to help, but the project is too big for the manufacturers and federal agencies to handle at the present time unaided.

CHAPTER V

AERIAL ROUTES

By JOHN R. CAUTLEY

As the automobilist seeks the best roads from city to city, so will the aerial traveller seek the best routes when engaged in a cross-country flight. An aerial route is determined by the character of the landing fields in the various cities over which the pilot chooses his course. In a flight across-country it is necessary to take into account the places where supplies of gasoline, oil, and spare parts may be obtained, where proper protection from the weather is afforded for the airplane, and above all where there are good landing fields.

With the increasing reliability of aircraft engines the character of the terrain between the landing points is not of such great moment as the condition

of the terminals at the end of the flight. Therefore, those cities that will prepare landing fields will surely reap the advantage of controlling the course of the aerial routes across the country. Attention is called to the great Transcontinental Race. This flight needed good fields to accommodate the fifty or more airplanes that started across the continent. The originators of the race selected those cities that had, in most cases, already established landing fields. The route of the flight was, more or less, already determined before the race was proposed. Other similiar cases could be pointed out, but this one is sufficient to illustrate the fact that the aerial routes depend on the establishing of fields.

Aircraft companies are only waiting until landing field facilities are available to launch a large number or projects that will in time connect all of the important commercial centres of this country with a rapid system of transportation.

CHAPTER VI

NAVAL AIR PORTS

By Lieut. W. H. Green, *U. S. Navy*

JUST as is a landing field for land planes, the site of air ports for seaplanes and flying boats is of prime importance. The best location for an air port is one at a safe distance from the haunts of shipping, bathing beaches, or pleasure grounds. The average flying water craft needs no great amount of water depth for landing or taking off, so it usually is not difficult to select a site where piers and the anchorage of vessels are eliminated.

The reason for avoiding ships, both of the merchant and pleasure craft type, is obvious. A flying boat lands at too great a speed to enable vessels to get out of the way. It is desirable to

locate the station, all other things being equal, on a comparatively narrow stretch of water, an inland bay or river being preferable because there is practically no seaway. For instance, it would be much more desirable to locate a seaplane station on Hempstead Bay or Oyster Bay than to locate one on Long Island Sound. On the sound the waves are big and there is a considerable seaway in any sort of windy weather. Water currents added to the natural air currents make it doubly hard to get the seaplane to the beach, for the purposes of drawing it into the hangar, refueling, or repairs.

Another item to be taken into consideration in the selection of a site, which is of more importance to a commercial air port than to a naval station, is that of proximity to an aeronautical landing field. In other words, freight, express, or passengers crossing the water by seaplane will, in the natural course of aeronautical development, desire to continue the trip by plane, so it would be advisable to have the air port near to the landing field. As

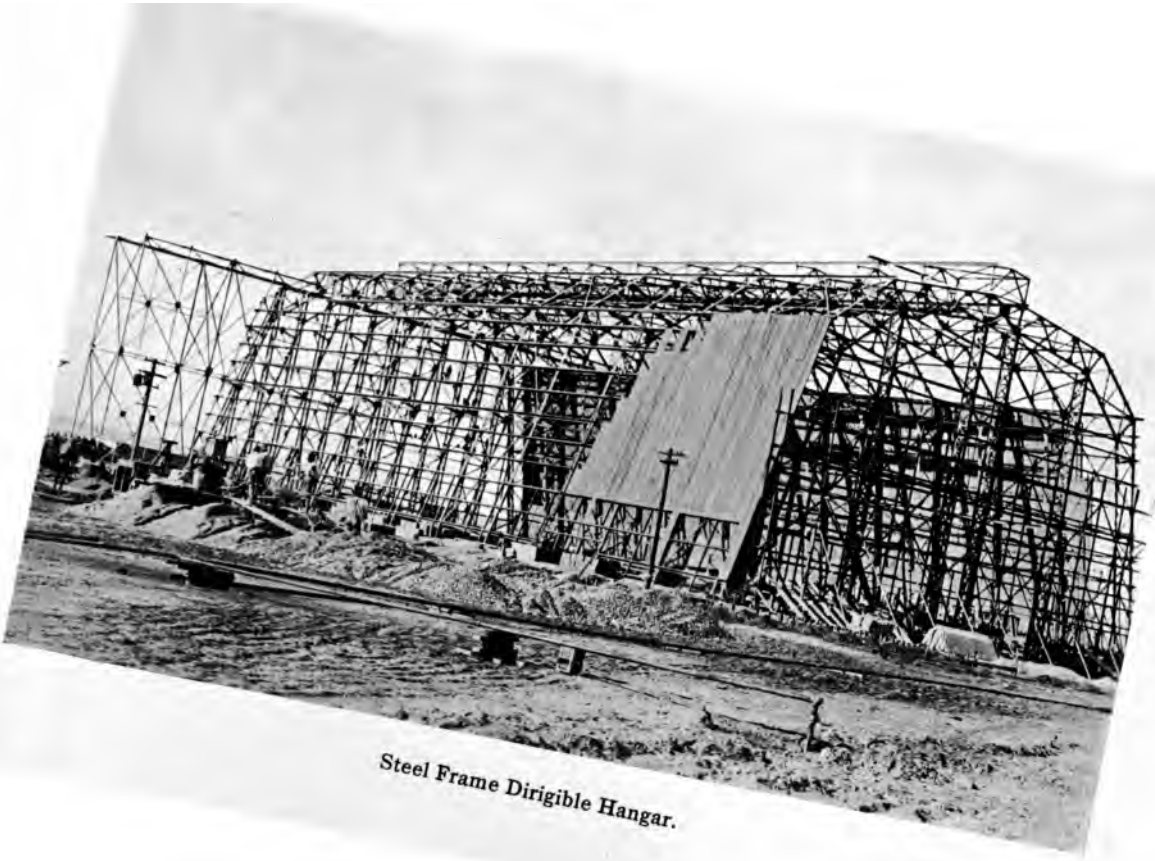
a matter of fact, it would be well to combine the two.

Another important consideration should be the proximity of good roads so that supplies may be brought to the station with ease. For such purposes the spur of a railroad track might be desirable. Any municipal commission, or committee appointed by a civic association, which is going into the question of air ports and landing fields, should spend a very considerable time in selecting the best possible site. Meteorological reports should be carefully studied in order to gain a knowledge of the prevailing winds in the particular port, and the station should be arranged so that all planes may conveniently take off and land in the face of the wind.

The size of an air port quite naturally depends upon the number of seaplanes which it is expected will use it. An inland stretch of water, one mile square, would be extremely desirable. This would enable any reasonable number of planes—a dozen or more—to operate with safety at the same time.

However, such a large stretch of water, while desirable, is not absolutely essential. Naval aviators have found that they can make a landing within a channel four hundred yards long and not less than five times the span of the wings in width, providing the wind parallels the channel. An expert pilot can do it successfully in three times the span, but the very least that the ordinary driver of a plane should attempt is five. A good boat ought to get off at its slowest speed and within a distance of four hundred yards.

As yet the Navy Department has had insufficient request for plans for municipal air ports to warrant drawing them up. Of course plans and specifications for naval air stations have been drawn with the utmost care and from them one may draw fairly accurate conclusions as to the hangars, shops, and personnel necessary for the average municipal air port. I am not attempting to give any estimate of the cost of such a station because of the wide range in the price of labour and materials in different parts of the United States



Steel Frame Dirigible Hangar.

NAVAL AIR PORTS

The following is a brief description of a Class B naval air station which has a complement of sixty officers and 550 men, and the repair and police force necessary in the operation of twenty-four planes with an average of ninety-six feet wing span:

2 buildings 112′ x 20′ for pilots' quarters
6 buildings 105′ x 20′—dormitories for working force
1 building 119′ x 20′ for mess hall
1 " 105′ x 20′ for carpenter shop
1 " 120′ x 30′ for machine shop
Hangar — 200′ x 150′ x 50′
1 building 105′ x 20′ for garage
1 " 36′ x 80′ for technical storeroom
1 motor test shed—Navy design for a two motor overhaul

One would have to reduce such a station considerably to make it available say for five pilots instead of sixty and for from five to ten planes as against twenty-four planes. No living quarters for pilots would be necessary nor would there be a need for dormitories for the working force. A

small building in which the pilots could rest is essential. However this might also serve as a waiting-room for passengers and an express transfer station. There would be need of a carpenter shop. However, instead of the navy specifications of 105′ x 20′ it could be reduced to 50′ x 20′; the technical storeroom to about 20′ x 30′, while the garage need not hold more than one truck and one small touring car. These buildings should be of fireproof construction, that is, a steel frame with corrugated iron cover. Of course the Army Type A steel hangar would be ideal but it would be too expensive for the average municipality. It is desirable to use asbestos lining in the buildings.

The hangar might be reduced to around 75′ x 100′ x 21′. None of these buildings should be very high. The field should be equipped, if possible, with underground tanks of galvanized iron for fuel storage. The navy tanks hold a maximum of ten thousand gallons. This could be easily cut in half, if not reduced to 3300 gallons, for a municipal air port. At the newest type naval

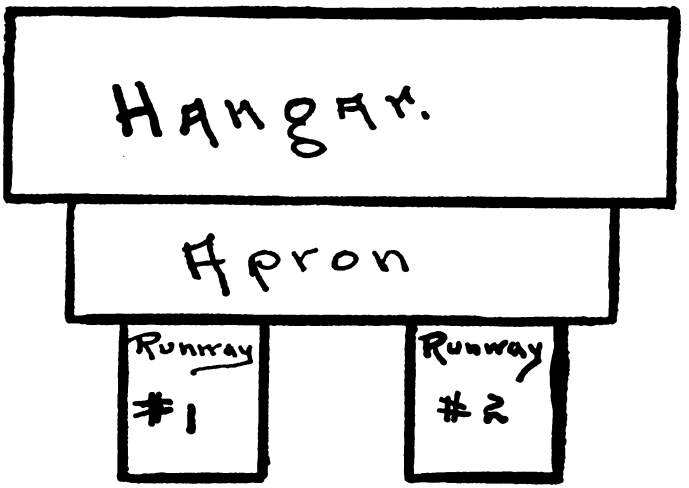
stations the gas is pumped up with an electric pump, which is extremely desirable. Proof of its desirability may best be had if one tries to pump 150 gallons of gas by hand in re-fueling a flying boat.

The amount of fuel to be kept on hand must be judged by the number of flying boats and the type of engines which they use which go in and out of the station. For instance, a 150 H. P. Wright motor would use about ten gallons per hour while one of the Liberty 400's would consume twenty-five gallons in the same time.

There is no standard for oil storage. Most naval stations keep oil in steel drums and draw it out as needed. However, it is well to be equipped with one of the small portable oil and gas tanks of the type usually found at a good garage.

The hangar should be located, as I have previously stated, so that planes can take off into the prevailing wind and also land into the wind. In order to reduce taxiing as much as possible, it is a good idea to have the hangar arranged so that the

plane can be taken down the runway into the water and prepared to take off immediately without taxiing into position. The question of tides has an important bearing on the site of the hangar. It



Plan of hangar of flying boats with apron and runways.

should be located about seventy-five feet from the high-water mark. If possible the station should not be located on a beach, which, when the tide is out, becomes a mud flat. The difficulty of getting into the hangar of such a station is apparent.

It is such problems as these which make it

A Modern Airship Hangar on the East Coast of the United States.

exceedingly difficult to draw up a uniform plan of hangar with its apron and runways. It is desirable to have the apron, or front porch as one gob called it, constructed of concrete, while the same material naturally makes the best runways. Concrete aprons facilitate the handling of the machines for minor repairs, re-fueling, etc. One general rule may be followed in constructing the apron and that is, it should be deeper than the overall width of the largest machine housed in the hangar. In building concrete runways the concrete must be laid with a caisson, which makes it very expensive. Properly treated hard woods of the general type of railroad cross ties might be used with good effect in that portion of the runway which is covered by water at high tide. No runway should exceed in pitch 20°, and that slant should be used only where there is no beach available and the hangars are constructed on a high bluff. It would be next to impossible to get a plane in and out of the water if the angle of the runway were more abrupt. If the runway is not properly constructed very often

the planes must be left in the water over night, which is not desirable.

The station should also be provided with a tractor for pulling the planes out of the water and for putting them in place. Otherwise it is necessary very often to use the entire personnel of the station for hauling lines.

Air harbours are in no sense limited to seaports. Scores of inland towns adjacent to great rivers, the Great Lakes, and other large bodies of water should be equipped with them. Even cities and towns connected with the larger bodies of water by rivers and small lakes should have air harbours. A flying boat flight from such a harbour is not dangerous, even though a part of the journey to the larger body of water be over land, provided the pilot can get his altitude quickly. There is no danger in flying over land if the pilot can reach water by gliding in the event his engine stops or some other unforeseen or untoward incident occurs. The distance ratio for gliding is about 5 to 1, that is, for every one thousand feet that the aviator

ascends he may glide five thousand feet to make a landing.

The question of personnel at an air port is extremely important. It is necessary to have an aeronautical mechanic, preferably a man who has been in the Naval Air Service, to take charge of the machine shop. Such a man with one or two assistants could, I should think, easily handle a port where four or five flying boats were harboured. One or two ex-navy or ex-army carpenters should be able to handle the carpenter shop, with the assistance of an ordinary carpenter or two.

The port should be in charge of an ex-officer of the Naval Air Service preferably, or an ex-chief petty officer who is competent to inspect planes prior to flight. Such inspection by a competent air port official is necessary to insure against crashes caused by mechanical difficulties.

A stock of supplies should be kept on hand containing the parts mostly in demand.

The machine and carpenter shops for an air port should have much the same equipment needed for

landing fields, which is described elsewhere in this volume.

Just as in the case of a landing field for land planes, the probable growth of an air harbour should be taken into consideration.

While lighter-than-air craft serve the navy's purposes extremely well and always will be an important branch of a maritime military establishment, nevertheless their care and housing facilities for overseas work will be but very little different from that of the same type of craft which fly over mountains and rivers and land. I might say, however, that the field for handling these craft must be very large. A ship of the R-34 type needs at least one thousand acres of clear ground in order to manœuvre properly. The ground must be flat, free from creeks and natural obstructions, well drained and always kept in excellent condition.

All buildings must be extremely low, more so than with the heavier-than-air craft. In the opinion of a great many high naval authorities the lighter-than-air machine—the dirigible of rigid

type—is the ultimate commercial air vehicle for it will carry the heaviest weight. Such a field must be rather far away from the coast to avoid as much as possible strong winds and air currents. It is extremely difficult to handle craft of this type after landing, if a strong wind is blowing. The R-34 will some day, I believe, be considered small, despite her 2,500,000 cubic feet gas capacity. The R-38 building in England for the navy contains 2,750,000 cubic feet and I believe freight-carrying commercial air vehicles will in a few years contain 10,000,000 cubic feet. As soon as the naval field at Lakehurst, New Jersey, is completed, the navy expects to begin building these super lighter-than-air machines. The hangars have been described in detail elsewhere.

CHAPTER VII

AIRPLANES AND SEAPLANES

By Captain Thomas T. Craven, U.S.N., *Director of Naval Aviation*

A large and prosperous city does not simply "happen." There is always some reason why it has prospered more than other communities around it. Until the last century the basic reason for prosperity and size was usually a good harbour, a navigable river, nearness to coal, iron, or other mineral deposits, unusually fertile ground, or some other natural condition. The advance of civilization has been measured directly and precisely by the improvements in transportation. In opening up the commerce of the world and in creating and improving the lines of communication more than through any other means has the business of the world and the progress of civilization been fostered.

AIRPLANES AND SEAPLANES

In the last century the locomotive and the automobile came into existence, and with them came two more reasons why a town should increase in population and wealth. These were railroad lines and good roads. The towns whose citizens first recognized the importance of these two great mediums of transportation were boomed enormously when, through the enterprise of farseeing residents, advantages were offered to railroads and good roads were provided for automobilists to attract them. The railroad in its growth throughout the United States has created thousands of towns along its lines, and has dwarfed or killed many others not near its path. The automobile, following the line of good roads, has added much to the wealth and to the size of the communities through which it passes. Any town on the Lincoln Highway, for example, owes much to the automobile.

At the present time a new means of transportation, the airplane, is just taking its place beside the automobile and locomotive as a factor in the rise

and fall of towns. Unlike its two rivals, however, the airplane needs no road or track, for the air is its broad highway, and it can go anywhere—over mountains and deserts, rivers and forests—where the automobile and locomotive are useless. It travels across country at a speed with which neither of its rivals can ever hope to compete. It makes but one demand upon the community it benefits—a safe place to land.

It may be argued that it would be foolish for a municipality to provide a landing field at the present time when only occasionally are airplanes seen in flight near it. The answer is that probably one reason why planes are not seen more often is that the pilots know there is no prepared place to land near it. Comradeship among airmen is strong, and news travels among them as rapidly as their swift planes fly, so pilots are usually aware of what towns to land at and what towns to avoid. The rapidly increasing number of pilots and planes will continue to shun towns without fields. Although at present the town seems entirely able to get along

A Splendid Landing Field in Process of Construction.

An Active Field with Possibilities of Greater Expansion.

without aircraft, ten years from now it may not be.

The present usual type of plane which carries two or three passengers is comparable only to the automobile, but already larger "ships" are being built everywhere and soon planes will rival the railroad or steamship in their passenger or even freight-carrying ability. Fifty-one passengers have flown in one of the NC naval seaplanes. Several tons is no longer a large load for a big multi-motored plane. Caproni, the Italian inventor, is working on a 100-passenger plane. These are a few of the indications of what airplanes will be in the future. It will be noted that up to the present the tendency seems to have been to build seaplanes capable of carrying the largest loads. The reason for this is that the water, when in sufficient area, supplies an always-available landing field. There are those who think that the first developments for freight carrying on a large scale will be through the agency of seaplanes, but this cannot be until the proper facilities are supplied. It is obvious

that without facilities on which planes can land and take off, air traffic cannot be economically and advantageously conducted. Therefore, the towns that read the signs of the times now will reap the advantage within a few years.

Eventually two distinct types of airplanes will come into being and in their flights favour only towns with adequate air harbours or landing fields. One type will be the small plane, fast or slow, carrying a few people and a little baggage, and owned by a private individual, as a touring car is now owned. The other type will be the huge, many-motored craft, manned by a regular crew, owned by a transportation company, and engaged in a regular passenger or freight carrying service over regular routes between various cities. Those cities will profit greatly not only by the rapid service offered their citizens, but by the erection of great repair shops, factories, gasoline stations, air terminals, and hotels. This will not happen in a day, but the establishment of a landing field cannot now be regarded as a very long term

investment. The returns will come within a few years.

Already a number of cities are benefiting by the air mail service, and within a short time this rapid mail system will be extended far and wide over many routes throughout the country. The municipalities which co-operate are the ones which will benefit, of course.

Although many, who look into the future, see the day when the long haul on railroads will be done away with by the more rapid aerial transportation, for some years the airplane will probably content itself with carrying the fast express, leaving to the railroads the great bulk of material which is not needed anywhere in a hurry. Passengers, however, are likely soon to be shifted in ever-growing numbers from grimy coaches to the clean and luxuriously furnished cabins of air liners. The airplane, as an auxiliary to the railroad, proved incontrovertibly its worth during the rail strike in England, when everything from milk to men was carried on schedule.

MUNICIPAL LANDING FIELDS

At the present time air lines, air commuters, and air tourists are already creeping into existence where flying fields make them possible. Among the cities, which already have municipal airdromes, are Tucson, Ariz.; Macon and Waycross, Ga.; Cœur d' Alene, Idaho; Chicago, Ill.; Wichita, Kan.; Taunton, Mass.; Detroit, Mich.; Minneapolis, Minn.; Kansas City, Mo.; Billings, Mont.; Battle Mountain, Nev.; Albany and Rochester, N. Y.; Newark, N. J.; Bryan and Cleveland, O.; Scranton, Pa.; Bristol, Tenn.; LaCrosse and Milwaukee, Wis.; and Atlantic City.

Of course these by no means complete the list of good landing places in this country. Commercial fields in ever-increasing numbers are being put into service; army fields are used by many commercial machines; and cities and towns are almost daily making provision for fields. In addition there are about one thousand fields scattered throughout the country which are classified as "emergency" fields; small fields, but large enough for a plane to land in on a pinch.

The big work of providing a system of air harbours so that regular aerial transportation on a large scale may be undertaken remains to be done, and the municipalities that do their "bit," will profit many-fold from their investment.

APPENDIX

UNITED STATES LANDING FIELDS

The attached unofficial list indicates towns and cities at which aircraft have landed. The present condition of fields is not considered. Fields listed are those subject to either commercial, municipal, or United States Government control. This classification includes:

Emergency Fields designated *—Those fields at which landings have been made but where no facilities exist for obtaining supplies.

Municipal Fields designated †—Those fields under the control of city governments or Chambers of Commerce.

Government Fields designated ‡—Stations, Fields, or Reservations operated by and under the control of the United States Government.

The list is arrange by States and cities alphabetically.

LIST OF LANDING FIELDS ON FILE IN THE OFFICE OF THE CHIEF OF AIR SERVICE

ALABAMA

*Albany
*Andalusia
‡Anniston
*Athens
*Auburn
*Autaugaville

APPENDIX

*Bay Minette
†Birmingham
*Brewton
*Camden
*Centerville
*Clanton
*Deatsville
*Demopolis
*Elmore
*Enterprise
*Eufaula
*Eutaw
*Evergreen
*Fayette
*Florence
*Gadsden
*Greensboro
*Greenville
*Grovehill
*Hayneville
*Huntsville
*Hurtsboro
*Jasper
*Jemison
*Linden
*Marion
*Marion Junction
*Monroeville
‡Montgomery
*Ozark
*Prattville
*Selma
*Speigners
*Thomasville
*Tuscumbia
*Uniontown
*Verbena
*West Blockton

ARIZONA

‡Àjo
‡Douglas
*Flaggstaff
*Fort Huachuca
*Grand Canyon
*Holbrook
*Kingman
*Maricopa
*Naca
*Phœnix
†Tucson
*Wilcox
†Yuma

ARKANSAS

*Arkadelphia
*Batesville
*Berryville
*Blytheville

APPENDIX

*Brinkley
*Buffalo Creek
*Danville
*Dardanelle
*De Witt
*El Dorado
*Fayetteville
*Forrest City
*Fort Smith
*Harrison
*Hazen
*Helena
*Hope
*Hot Springs
*Jonesboro
‡Little Rock
‡Lonoke
*Marked Tree
*New Boston
*Newport
*Paragould
*Pine Bluff
*Prescott
*Stuttgart
*Texarkana
*Warren
*Wynne

CALIFORNIA

*Alameda
‡Arcadia
†Auburn
‡Bakersfield
†Bay Point
*Beaumont
*Berkeley
*Bloomington
*Blythe
*Brawley
‡Calexico
*Calipatria
‡Camp Kearney
*Chico
*Chinese
*Chino
*Colusa
*Corona
*Cottonwood
*Daggett
*Dominegoni Valley
†El Centro
*Eureka
*Fallbrook
†Fresno
*Gridley
*Hemet
*Hollister
†Hollywood
*Lancaster

APPENDIX

‡Lakeport
†Los Angeles
*Los Gatos
*Madera
*Marysville
*Maxwell
*Mecca
*Merced
*Modesto
*Mojave
*Needles
*Nevada City
*Newman
*Oakland
*Oroville
*Palmdale
*Palo Alto
†Pasadena
†Porterville
*Petaluma
*Quincy
‡Red Bluff
*Redding
†Redwood City
‡Riverside
*Rocklin
‡Sacramento
*San Bernardino
‡San Diego
*San Fernando
‡San Francisco
*San José
*San Leandro
*San Mateo
*Santa Anna
†Santa Barbara
*Santa Clara
*Spadra
†Stockton
*Temecula
*Tulare
*Visaila
*Woodland
*Woodlawn

COLORADO

*Aguilar
*Aspin
*Buena Vista
*Burlington
*Colorado Springs
†Denver
*Flagler
*Glenwood Springs
*Grand Junction
*Limon
*Pueblo
*Red Cliff
*Salida
*Trinidad

APPENDIX

CONNECTICUT

*Ansonia
*Hartford
*Meriden
*Middletown
*New London
*Pawcatuck
*Plainville

DELAWARE

*Middletown
*Newark
*Wilmington

DISTRICT OF COLUMBIA

‡Anacostia
‡Washington

FLORIDA

‡Arcadia
†Avon Park
*Baldwin
†Bartow
*Bonifay
*Bradentown
*Brooksville
*Daytona
*Daytona Beach
*De Funiak Springs
*De Land
*Eustis
*Fort Meade
†Fort Myers
*Fort Pierce
*Gainesville
*Gladecrest
*Glendale
*Hobe Sound
*Immokalee
‡Jacksonville
‡Key West
†Kissimmee
*La Belle
*Lake City
†Lakeland
*Leesburg
*Live Oak
*Marianna
†Miami
*Moorehaven
*Moultrie

APPENDIX

*North La Belle
†Ocala
†Okechobee
†Orlando
*Ormond
*Palmdale
‡Pensacola
*St. Augustine
*St. Cloud
*Sanford
†Sarasota
*Seabreeze
*Seabring
*Tallahassee
†Tampa

GEORGIA

†Albany
‡Americus
*Ashburn
*Athens
*Atlanta
‡Augusta
*Belleville
*Blakely
‡Brunswick
*Buena Vista
‡Columbus
*Canton
*Cordele
*Cumberland Island
*Dawson
*Douglas
*Ellaville
*Fitzgerald
†Fort Valley
*Gracewood
*Griffin
*Hawkinsville
*Helena
*La Fayette
†McRae
†Macon
*Marietta
†Marshallville
*Milledgeville
†Montezuma
*Moultrie
*Oglethorpe
*Omaha
*Plains
*Richland
*Rome
†Savannah
*Shellman
*Sugar Valley
*Sylvania
*Sylvester
*Thomaston

*Tifton
*Valdosta
*Vidalia
*Washington
†Waycross
*Waynesboro
*Wrens

IDAHO

*Athol
*Belmont
†Cœur d'Alene
*Corbin
*Garwood
*Hauser
*Moscow
†Pocatello
*Rathdrum
*Twin Falls
*Twin Lakes

ILLINOIS

*Abington
*Aledo
*Alton
*Aurora
*Avena
*Beckemeyer
‡Belleville
*Belvidere
*Blandenville
*Bloomington
*Breese
*Brownstown
*Caberry
*Carlinville
*Carlyle
*Carrollton
*Carterville
*Casey
*Cedar Point
*Centralia
*Champaign
*Charleston
*Chatsworth
‡*Chicago
*Clinton
*Corina
*Damiansville
*Danville
*Decatur
*Delavan
*Dennison
*Dow
*Dupo
*Du Quoin

APPENDIX

*Effingham
*Elgin
*Elmwood
*Fairfield
*Fieldon
‡†Forest Park
(Suburb of Chicago)
*Freeburg
*Galesburg
*Girard
*Goreville
*Gorham
*Greenup
*Greenville
*Harvel
*Havana
*Hettick
*Highland
*Hinkley
*Jerseyville
†Joliet
*Kankakee
*Keenes
*Kempton
*La Salle
*La Harpe
*Le Roy
*Litchfield
*Lora
*Macomb
*Lincoln
*Malta
*Marshall
*Mascoutah
*Matoon
*Mendota
*Meredosi
*Metropolis
*Monmouth
*Monticello
*Montrose
*Morris
*Morrisonville
*Mt. Olive
*Mt. Sterling
*Mt. Vernon
*Murphysboro
*New Baden
*New Memphis
*Newton
*Odin
*O'Fallon
*Olney
*Ottawa
*Pana
*Paris
*Peoria
*Percy
*Pierron
*Pinckneyville
*Pontiac
*Princeton

*Ramsey
‡Rantoul
*Robinson
‡Rockford
*Rock Island
*Rood House
*Roseville
*Sadorus
*St. Charles
*St. Elmo
*St. Jacob
*Salem
*Sandoval
*Shelbyville
*Shumway
*Sparta
*Springfield
*Staunton
*Streator
*Sullivan
*Sumner
*Swanwick
*Tallula
*Tamarosa
*Trenton
*Troy
*Urbana
*Vandalia
*Wagoner
*Watseka
*Waukegan
*Wedron
*Wheaton
*Winchester
*Woodlawn

INDIANA

*Attica
*Boswell
*Brazil
*Butler
*Effingham
†Evansville
‡Ft. Benjamin Harrison
*Ft. Wayne
*Fowler
*Frankfort
*Hamilton
‡Indianapolis
*Ireland
*Knox
†Kokomo
*La Fayette
*Logansport
*Loogootee
*Mt. Vernon
†New Castle
*New Harmony
*New Richmond

*Petersburg
*Schereville
*South Bend
*Spencer
*Sullivan
*Terre Haute
*Vincennes
*Wabash
*Washington

IOWA

*Atlantic
*Blairsburg
*Bonaparte
*Charles City
*Clarion
*Davenport
‡†Des Moines
*Donnelson
*Dow City
*Eldora
‡Iowa City
*Lowden
*Mason City
*Northwood
*Osage
*Oskaloosa
*Pella
*Rockford
*Rockwell City
*Sac City
*Shell Rock
*Sioux City
*Stanwood
*Waterloo

KANSAS

*Abilene
*Arkansas City
*Belleville
*Cottonwood Falls
*Dodge City
†Emporia
*Eureka
‡Fort Leavenworth
‡Fort Riley
*Fort Scott
*Fredonia
*Garden City
*Goodland
*Hiawatha
*Iola
*Kensington
*Kingman
*Kinsley
*Lincoln
*McPherson

*Mankato
*Marysville
*Norton
*Olathe
*Parsons
*Phillipsburg
*Pratt
*Scott City
*Seneca
*Smith Center
*Topeka
†*Washington
Wichita

KENTUCKY

*Corydon
*Georgetown
‡Louisville
*Midway
*Morganfield
*Paducah
‡West Point
*Wingo

LOUISIANA

‡Alexandria
†Baton Rouge
*Crowley
†Delta
*Eunice
*Harrisonburg
*Jennings
*Kinder
*La Fayette
‡Lake Charles
*Lake Providence
*Minden
*Monroe
*Natchitoches
*New Orleans
*Opelousas
*Shreveport
*Tallulah

MAINE

*Augusta
*Lewiston
*Old Town
*Portland

MARYLAND

‡Aberdeen
†Baltimore
‡Camp Meade
*Chase

‡College Park
*Elk Mills
*Emmitsburg
*Hagerstown
*Havre de Grace
*Laurel
*Northeast
*Sparrows Point

MASSACHUSETTS

*Amherst
*Ashburnham
†Bedford
*Beverly
*Boston
*Boxford
*Brockton
*Cambridge
‡Chatham
*Deerfield
*Essex
*Falmouth
*Grafton
*Hamilton
*Hudson
*Marlborough
‡New Bedford
*Newburyport
*Northampton
*Orange
*Pittsfield
*Princeton
*Readville
*South Framingham
*Springfield
†Taunton
*Upton
†Weston
*Weymouth
*Worcester

MICHIGAN

*Adrian
*Albion
*Almont
*Ann Arbor
*Bad Axe
‡Battle Creek
*Bay City
*Buchanan
*Caro
*Chelsea
*Croswell
*Dearborne
*Decatur
*Delhi Mills
†Detroit
*Dexter

APPENDIX

*Dowagiac
*Flint
*Fowler
*Fowlerville
*Glenwood
*Grand Haven
†Grand Rapids
*Hillsdale
*Imlay City
*Jackson
*Kalamazoo
*Lansing
*Lapeer
*Lawton
*Manchester
*Mayville
*Milan
‡Mount Clemens
*Mount Pleasant
*Niles
*Plymouth
*Pointe aux Barques
†Roseville (Suburb of Detroit)
*St. Charles
*Sandusky
*Standish
*Stockbridge
*Wayne
*Yale
*Ypsilanti

MINNESOTA

*Appleton
*Breckenridge
*Cannon Junction
*Clara City
*Crookston
*Crow River
*Dakota
*Dresbach
*Duluth
*Fairmont
‡Fort Snelling
*Golden
*Graceville
*Hastings
*Lake City
*Maple
*Mayer
*Maynard
*Milan
*† ‡Minneapolis
*Minnesota City
*Montevideo
*New Germany
*Parker
*Pine Creek
*Red Wing
*†‡Saint Paul
†Sleepy Eye

*Valley
*Wabasha
*Waconia
*Wayzata
*Wheaton
*White Rock
*Willmar
†Winona

MISSISSIPPI

*Artesia
*Belzoni
*Biloxi
*Canton
*Charleston
*Clarksdale
*Como
*Corinth
*Greenville
*Grenada
*Holly Springs
*Jackson
*Kosciusko
*Louisville
*Madison Station
*Meridian
*Newton
*Senatobia
*Tupelo
*Tutwiler
*Vicksburg
‡West Point

MISSOURI

*Booneville
*Bowling Green
*California
*Cape Girardeau
*Caruthersville
*Centralia
*Chaffee
*Chillicothe
*Dexter
*Fayette
*Festus
*Flat River
*Hamilton
*Higginsville
*Independence
*Ironton
*Jefferson City
*Jonesburg
†Kansas City
*Keota
*Leasburg
*Lebanon
*Malden
*Marshall

APPENDIX

*Monett
*Monroe City
*New Florence
*New Haven
*New London
*Paris
*Pascola
*Poplar Bluffs
*Richland
*Rolla
*St. Genevieve
*St. Joseph
*St. Louis
*Sedalia
*Seneca
†Springfield
*Sturgeon
*Sullivan
*Washington
*Wentsville

MONTANA

*Arlee
*Bigtimber
†Billings
*Bozeman
*Bridger Creek
*Columbus
*Dixon
*Drummond
*Elliston
‡Fort Harrison
*Garrison
*Glendive
*Great Falls
‡†Helena
*Heron
*Kalispell
*Laurel
†Livingston
*Manhattan
‡Miles City
*Mission
†Missoula
*Paradise
*Park City
*Perma
*Plains
*Reid Point
*Thompson Falls
*Townsend
*Winston

NEBRASKA

*Central City
‡Fort Crook
*Loup City
*Nebraska City

APPENDIX

*North Platte
*Ogallala
†Omaha
*Saint Paul
*Sidney
*Wahoo
*York

NEVADA

*Battle Mountain
*Carson City
*Elko
*Fallon
*Lovelocks
*Montello
†Reno
*Winnemucca

NEW HAMPSHIRE

*Lancaster
*Portsmouth

NEW JERSEY

†Atlantic City
‡Cape May
†Hasbrouck Heights
†Keyport
*Lakehurst
‡Newark
*Perth Amboy
†Pine Valley
†Pompton Lakes
*Princeton
‡Rockaway

NEW MEXICO

†Albuquerque
†Almagordo
*Carlsbad
†Cerrillos
*Chapelle
*Clayton
‡Columbus
‡Deming
*Des Moines
*Gallup
*Hachita
*Las Vegas
*Lordsburg
*Onava
*Optimo
*Santa Fé

*Shoemaker
†Taiban
†Texico
*Tucumcari
*Wagon Mound
†Willard

NEW YORK

†Albany
†Binghamton
*Birdsell
*Brooklyn
†Buffalo
*Coney Island
*Cranberry Lake
*Dunkirk
*Goshen
†Ithaca
*Jay
*Keeseville
†Lake Placid
*Liberty
*Little Falls
†Lockport
*Lowville
*Millerton
†New York City
*Oneida
*Orchard
*Oswego
*Piercefield
‡Plattsburg
‡Plum Island
*Port Jervis
*Poughkeepsie
*Pulaski
†Rochester
*Saranac Lake
†Saratoga Springs
†Schenectady
*Sheepshead Bay
*Silver Creek
‡Staten Island
†Syracuse
*Tarrytown
*Union
†Utica
*Waterloo
*Westfield
*Yonkers

LONG ISLAND

†Amityville
*Au Sable Forks
*Babylon
†Baldwin
‡Belmont Park
‡Camp Upton

†Central Park
‡Commack
†Copaigue
‡Mineola
*Montauk Point
†Port Washington
‡Rockaway
†Wantagh

NORTH CAROLINA

*Asheville
†Charlotte
*Dunn
‡Fayetteville
*Goldsboro
†Greensboro
*Hobgood
*Hoffman
‡Moorehead City
†Pinehurst
*Pineview
†Raleigh
*Weldon
*Wilmington
*Wilson
†Winston-Salem

NORTH DAKOTA

‡Bismarck
*Dickinson
*Eagles Nest
*Eldridge
*Fargo
‡Fort Lincoln
*Glen Ullin
*Grand Forks
*Hobart
*Jamestown
*Judson
*Mandan
*Sedalia
*Sims
*Sunny
*Sweet Briar
*Valley City
*Williston

OHIO

*Akron
*Bowling Green
‡Bryan
*Cambridge
*Cedar Point
†Cincinnati
†Cleveland
*Columbus

†Coshocton
‡Dayton
*Delaware
‡Fairfield
*Lima
†Mansfield
*Minerva
*Newark
*New London
*Pataskala
*Piqua
*Sandusky
*Toledo
*Warren
*Wellston

OKLAHOMA

*Ada
*Ardmore
*Atoka
*Blackwell
*Blanchard
*Bristow
*Chandler
*Chattanooga
*Cheyenne
*Chickasha
*Clarimore
*Cleveland
*Clinton
*Cordell
*Cushing
*Devol
*Drumright
*Duncan
*Durant
*Elk City
*Enid
*Fairview
‡Fort Sill
*Frederick
*Granfield
*Guthrie
*Hartshorne
*Hennessey
*Henryetta
†Hobart
*Holdenville
*Hugo
*Kingfisher
‡Lawton
*Lexington
*McAlester
†McLoud
*Macomb
*Mangum
*Marlow
*Mountain Park
*Muskogee

*Newkirk
*Norman
*Nowata
*Oklahoma City
*Pauls Valley
*Pawnee
*Ponca City
*Prague
*Purcell
*Ripley
*Sapulpa
*Shawnee
*Stillwater
*Stroud
†Texola
*Tishomingo
†Tulsa
*Vinita
*Walter
*Watonga
*Waurika
*Waynoka
†Woodward

OREGON

†Albany
*Arlington
*Ashland
‡Columbia River (Mouth)
*Corvallis
*Cottage Grove
†Dallas
†Eugene
†Grants Pass
*Grenada
*Imbeler
*Lebanon
†Medford
*Pendleton
†Portland
*Roseberg
*Salem
*The Dalles

PENNSYLVANIA

*Altoona
*Beatty
*Beaver Falls
‡Bellefonte
‡Bustleton
*Carlisle
*Chester
*Clearfield
*Du Bois
*Easton
*Erie
†Essington

APPENDIX

*Everett
*Gettysburg
*Harrisburg
*Huntington
†Johnstown
*Lancaster
*Lebanon
†Leetsdale
*Lewiston
*Ligonier
*Meyersdale
‡Middletown
*Milford
*Mount Union
*Mount Vernon
*New Brighton
*Penllyn
†Philadelphia
*Pittsburgh
*Reading
*Roaring Spring
*Rockwood
*Stroudsburg
*Uniontown
*Washington
*Wilkes-Barre

RHODE ISLAND

*Apponaugh
*Bradford
†Collingwood Race Track
*East Greenwich
†Hills Grove
‡Narragansett Bay
*Newport
*Providence
*Shannock
*Slocum
*Weed River Junction
*Woonsocket

SOUTH CAROLINA

*Aiken
*Bamberg
*Bennettsville
*Camden
*Charleston
*Chesterfield
‡Columbia
*Latta
*Sumter
*Tillman

SOUTH DAKOTA

*Aberdeen
*Redfield
*Sioux Falls

APPENDIX

TENNESSEE

*Albany
*Alexandria
†Chattanooga
*Cleveland
*Davis
*Dyersburg
*Fayetteville
*Huntington
*Jackson
*Johnson City
*Knoxville
*Lexington
†Memphis
*Morristown
‡Millington
*Nashville
*Somerville
*Sugar Tree
*Sweetwater
*Union City
*Woodbury

TEXAS

*Abbott
*Alief
*Alpine
*Alta Loma
*Altuda
*Amarillo
*Angleton
*Archer City
*Arcola
*Artesia
‡Austin
*Barstow
†Beaumont
*Beeville
*Belcherville
‡Benbrook
*Benchley
†Big Spring
*Benham
*Bowie
*Bridgeport
*Brownsville
*Brownwood
*Bryan
*Cactus
*Cameron
*Canadian
*Childress
*Chillicothe
*Cisco
*Clarendon
‡Corpus Christi
*Cotulla
*Crowell

APPENDIX

*Cuero
*Dalhart
‡Dallas
*Danbury
*Decatur
‡Del Rio
*Denison
*Desdemona
*Dickinson
*Dilly
*Eagle Lake
*Dolores Mines
*Electra
*Dryden
‡El Paso
*Eagle Pass
‡Everman
*Fairbanks
†Farwell
*Flatonia
*Fordyce
‡Fort Clark
*Fort Hancock
‡Fort Stockton
‡Fort Worth
*Fredericksburg
†Friona
*Gainesville
‡Galveston
*Georgetown
*Giddings
*Haskell
*Hempstead
*Henrietta
*Hester's Ranch
‡Hicks
*Hitchcock
*Hollis
*Hondo
*Hot Wells
‡Houston
*Huntsville
*Iowa Park
*Jolly
*Kaufman
*Kenedy
*Langtry
‡Laredo
*League City
*Lexington
*Liberty
*Longfellow
*Lubbock
*McKinney
†McLean
*Marathon
‡Marfa
*Marlin
*Marshall
*Menard
*Memphis
*Midland

APPENDIX

*Milford
*Mineola
*Moulton
†Mount Pleasant
*New Boston
*New Castle
*Nocona
*Odessa
*Orange
*Ozona
†Paducah
*Palestine
*Paris
*Pearland
*Pecos
‡Port Arthur
*Presidio
*Pumpville
*Quannah
*Richmond
*Ringold
*Rosenberg
*Saint Joe
*Saltillo
*San Angleo
‡San Antonio
*San Benito
*San Marcos
*Seymour
*Sherman
*Shumla
*Sierra Blanca
*Spoffard
*Stamford
*Stanton
*Sulphur Springs
†Sweetwater
*Temple
*Tesnus
*Texarkana
*Texline
*Thorndale
*Toyah
*Tyler
*Uvalde
*Van Horne
*Vernon
*Victoria
*Vinton
*Von Ormy
‡Waco
*Washburn
*Waxahachie
*Webb
*Wellington
*Wharton
*Whitesboro
‡Wichita Falls
*Wills Point